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SIMULATOR INDUCED SICKNESS IN THE CP-140 (AURORA) FLIGHT DECK SIMULATOR

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Abstract

Training on modern flight simulators can lead to a condition referred to as simulator induced sickness (SIS) which is characterized by nausea, dizziness and postural instability. It is believed that SIS results from exposure to conflicting sensory information. The present report examined the incidence, severity and duration of SIS as a function of flight experience and aircrew position (pilot/copilot) in 16 aircrew following training on the CP-140 (Aurora) Flight Deck Simulator at Canadian Forces Base Greenwood. The dependent measures included symptomatology and postural stability. In addition, measures of workload were taken to examine the contribution of the high task demands generally associated with simulator training to the development of SIS symptomatology. The results indicated that over 50% of tested aircrew experienced increases in symptom frequency following simulator training with the most commonly reported symptoms being mild mental fatigue, physical fatigue, eye strain and after sensations of motion. This increase in symptom frequency was unaffected by either flight experience or aircrew position and symptoms dissipated, for the most part, after a few hours. No changes in postural stability were observed. The workload results confirmed that the simulator imposed high task demands on the aircrew. Furthermore, the workload results were consistent with the pattern of symptoms observed, suggesting that factors other than sensory conflict may be involved in the development of symptomatology following simulator exposure. Future investigations should attempt to identify these factors so that SIS can be managed more effectively.

KEYWORDS: Simulator Sickness; Ataxia; Postural Control; Workload.

INTRODUCTION

Aircrew training typically involves extensive use of sophisticated ground based flight simulators. Such devices enable aircrew to experience a broad range of flight conditions and emergency procedures without jeopardizing aircrew safety or exposing aircraft to excessive wear. Flight simulators also enable aircrew to practice difficult aspects of missions in a fraction of the time required for similar air manoeuvres, consequently, task demands in many simulators may be relatively high compared to the actual aircraft.

In conjunction with this extensive use of flight simulators for training aircrew, there is growing concern that simulator training may be compromised by a phenomenon termed simulator sickness or simulator induced syndrome (SIS)(1). While a survey of four types of simulators, at seven US military sites, found that SIS is most commonly characterized by nausea, dizziness and postural instability (2), other symptoms frequently reported include fatigue and general malaise (1). These symptoms are not unlike those experienced during motion sickness (3) and space adaptation syndrome (4) and because such symptoms may persist for several hours, there is concern that they may impact on flight safety following simulator training (5). In some jurisdictions, this has resulted in restrictions that limit flying for several hours following simulator exposure (5).

SIS appears to be most pronounced in high performance fighter and helicopter simulators which use visual displays with wide fields of view and particularly active motion systems (5,6,7,8). It has been argued that the cause of SIS may be similar to that of motion sickness (2,6), namely exposure to conflicting sensory information and subsequent processes of adaptation (2,5,6).

Problems related to adaptation in novel environments tend to increase as conditions depart from the expected. Therefore, because experienced aircrew have highly refined expectations of aircraft handling characteristics, it has been suggested that the incidence of SIS should be most pronounced in experienced rather than in novice aircrew (2,5,9-12). Furthermore, one might expect experienced aircrew, in the pilot rather than copilot position, to be particularly susceptible because they would have the greatest potential for discrepancies to develop between expectations of the control/response characteristics of the real aircraft and those of the simulator.

Providing that simulator motion and visual systems are properly coordinated, SIS does not appear to be particularly severe in transport (13) and long range patrol aircraft (14). However, a severe case of SIS was recently reported with the CP-140 (Aurora) Flight Deck Simulator at Canadian Forces Base Greenwood. This incident and DCIEM's research focus on simulation prompted a request (15) for the following investigation.

To examine the incidence and severity of SIS resulting from exposure to the Flight Deck Simulator, symptomatology and postural control were examined in a number of aircrew prior to, and immediately following, simulator training. In addition, SIS symptomatology was examined 24 h later. Furthermore, measures of workload were collected to explore the possible extent to which the task demands associated with simulator training may contribute to the development of fatigue related SIS symptomatology.

METHOD

Pilots

Sixteen pilots scheduled for Flight Deck Simulator training participated in this study. Eight were assigned to a Novice and 8 to an Experienced group on the basis of their flight experience on the Aurora aircraft. The Novice group consisted of 4 pilots who had no experience with this aircraft or the simulator and 4 who had not flown the Aurora or the simulator during the past 3.5 years. Pilots in the Experienced group were currently engaged in tours of duty on the Aurora and had experience on the aircraft ranging from 400 to 2600 h (mean = 1628.75 h). Their last flight was between 1 and 5 days (mean = 3.5 days) prior to the commencement of this study and they were not acclimated to the simulator environment. Both the Novice and Experienced groups were similar in age, number of hours of sleep prior to the simulator sessions and total number of flight hours.

Apparatus

The Flight Deck Simulator is a Canadian Aviation Electronics flight simulator with visuals to each of the cockpit windows and a 6 degree of freedom motion platform. The control/response characteristics are programmed to reproduce the handling characteristics of the Aurora.

SIS symptomatology was assessed by means of a 28 item Symptom Questionnaire (16) (see Table 1) on which aircrew indicated symptom severity on a 4-point scale ('not present', 'mild', 'moderate' and 'severe'). Aircrew also completed a Delayed Symptom Questionnaire on which they reported time of onset and the duration of symptoms that occurred during the 24 h period following their simulator exposure. In addition, opinions regarding the fidelity of the simulator, as well as comments pertaining to how aircrew dealt with SIS were solicited by means of a separate Summary Questionnaire.

A force platform (Kistler; model CH-8408) was used to measure postural stability over a period of 68 sec. Such devices are commonly used to examine postural control or sway under clinical conditions (17) and this particular platform was used in a pilot study at DCIEM to demonstrate instability following exposure to circular vection. The force platform was connected to a portable computer (GRiD; model Case 3) which digitized the output of the platform at a sampling rate of 15 Hz. Sway was measured in Joules per Kilogram (J/Kg), i.e., raw force scores normalized for body weight. To produce a metric of instability, the 68 sec sway sample (sampled at 15Hz) was Fourier transformed and the power between 0.015 and 1.0 Hz was used as a measure of instability (18).

Estimates of individual subjective workload were obtained in two ways: using the NASA-Task Load Index (NASA-TLX) (19) and a global workload estimate (20). The NASA-TLX is a multi-dimensional workload measure where subjects rated their workload on six 18-point scales ('frustration', 'temporal demand', 'mental demand', 'physical demand', 'performance' and 'effort'). Each of the scale values were assigned weights on the basis of a separate pairwise comparison procedure administered to each individual. These weighted values were then combined to produce a measure of overall workload over the same 18-point range as the original scales. Details regarding the NASA-TLX and its implementation can be found elsewhere (19). The 18-point scale used in this study was taken from the Task-Load Index Paper and Pencil Package, Version 1.0, published by the Human Performance Research Group at the NASA Ames Research Center.

The global estimate of workload was obtained by means of magnitude estimation (20). This required aircrew to compare the workload they experienced in the simulator to a take-off and departure under visual flight rules (VFR) with visual meteorological conditions, in the aircraft with which they were most familiar. The latter was assigned a value of 100 and aircrew were asked to provide a comparative value that they felt corresponded to the workload they had experienced during the simulator session. If, for example, workload in the simulator was perceived by aircrew to be twice that of the take-off/departure comparison, aircrew would assign a value around 200 to the simulator session. Despite the numerical scale assigned to the workload estimate, the values are not meant to conform to a ratio scale.

Procedure

Each simulator training session was conducted with a crew of 3 (pilot, copilot and flight engineer) and two instructors (one for the pilot and copilot, and one for the flight engineer). Our investigation focused only on the pilot and copilot. Sessions lasted 4 h, with a 15 min break approximately midway through the session. After the break, the pilot and copilot exchanged roles.

For the Novice group, simulator sessions were similar prior to and following the break. The principal activities were take-offs, landings and flying circuits according to VFR and instrument flight rules (IFR). Unlike the Novices, training for the Experienced group was more advanced and tailored to the particular needs of each crew. However, activities common to their training included flying under IFR and VFR conditions, in and out of cloud, flying in high density areas and responding to numerous in-flight emergencies.

Since the first day of simulator training for the Novices was predominantly a cockpit familiarization session, this group was tested on the second day of their training program when they were actually involved in flying the simulator. On the other hand, because the Experienced group was familiar with the simulator, they were tested on their first day of training. Aircrew in both groups completed the Symptom Questionnaire before their simulator session (Baseline), after the first 2 h (after Phase 1) and after the second 2 h (after Phase 2). At this point, the pilot and copilot were asked to rate their workload for the entire 4 h session using the NASA-TLX and global procedures. Approximately 24 h after simulator exposure, the Delayed Symptom and Summary Questionnaires were administered.

Following each administration of the Symptom Questionnaire, two postural stability tests were administered on the force platform. The postures used for these tests were the Sharpened Romberg (SR) and Romberg (R). For the SR test, pilots were instructed to stand erect in a heel to toe stance with their weight evenly distributed on both feet, arms folded across the chest and eyes closed. The R test was identical to the SR, except that it involved standing with feet together. Each stance was maintained for 68 s or until either foot was moved or eyes were opened. In the rare instances where an individual failed to complete the test, it was repeated. The order of the tests was independently randomized for each administration.

RESULTS

Symptom Questionnaires

Table 1 provides a summary of the responses to the Symptom Questionnaires for the Novice and Experienced Groups at Baseline, after Phase 1, after Phase 2, and 24 h following simulator exposure. An examination of these data reveals that there was an increase in the number of symptoms reported following simulator exposure and that these were reduced after 24 h. The most commonly reported symptoms after exposure for both groups were 'mental fatigue' (item #4), 'physical fatigue' (item #7), 'eye strain' (item #23) and 'after sensations of motion' (item #13). Symptoms were predominantly rated as 'mild', however, three subjects (2 Novice and 1 Experienced) reported the occasional symptom as 'moderate'. No symptoms were reported as 'severe'.

Table 2 shows the number of subjects from the Novice and Experienced groups that reported any increase in symptom frequency from Baseline to the end of Phase 1, from Baseline to the end of Phase 2, and from the end of Phase 1 to the end of Phase 2. Overall, these data reveal that over 50% of all aircrew reported more symptoms following simulator exposure. Statistical examination of these data (Sign test) failed to show any significant differences in symptom frequency between the Novice and Experienced groups.

Since there were no differences between the Novice and Experienced groups with respect to the number of aircrew reporting increases in symptom frequency, the data

Table 1. Frequency of symptom occurrence for the Novice (Nov) (n=8) and Experienced (Exp) (n=8) groups at Baseline, after Phase 1, after Phase 2, and 24 hours after simulator exposure.

SYMPTOMS	Baseline		Phase 1		Phase 2		24-hr Delay	
	Nov	Exp	Nov	Exp	Nov	Exp	Nov	Exp
1. HEADACHE	1		1	1		1	1	1
2. VISUAL SENSATIONS OF MOVEMENT			1	1	1	2	1	1
3. DIFFICULTY CARRYING OUT FINE MOVEMENT			1		2	1		
4. MENTAL FATIGUE	1	2	4	2	5	3	2	2
5. VISUAL FLASHBACKS								
6. LOSS OF APPETITE								
7. PHYSICAL FATIGUE		2	3		4	3	3	2
8. GENERAL LOSS OF WELL BEING								
9. LEANS						2		
10. EXCESSIVE SALIVATION								
11. DIFFICULTY READING					1			
12. WALKING STRAIGHT TAKES MORE EFFORT					1	1		
13. AFTER-SENSATIONS OF MOTION			2	2	2	2	1	1
14. DROWSINESS/YAWNING	3	1	1		1		1	
15. DIFFICULTY MAINTAINING BALANCE						1		
16. DIFFICULTY PERCEIVING DEPTH			1	1	1			
17. STOMACH AWARENESS					1			
18. DIZZINESS								
19. DIFFICULTY CONCENTRATING		1	1		1			
20. LACK OF INTEREST								
21. BLURRED VISION			2		1			
22. VERTIGO								
23. EYE STRAIN			3	3	2	1	1	2
24. DESIRE FOR (COOL) FRESH AIR			1	3	1	2	1	1
25. ENERGY DRAIN					2	2	1	1
26. COLD SWEAT								
27. EXCESSIVELY DRY MOUTH					1			
28. DISORIENTED				1		1		
TOTAL	4	6	21	14	27	22	12	11

Table 2. Number of subjects from the Novice (n=8) and Experienced (n=8) groups that reported increases in symptom frequency from; Baseline to the end of Phase1, Baseline to the end of Phase 2, and the end of Phase 1 to the end of Phase 2.

Baseline To End Of Phase 1		Baseline To End Of Phase 2		End of Phase 1 To End Of Phase 2	
Novice	Experienced	Novice	Experienced	Novice	Experienced
6	3	6	4	5	4

from the two groups were pooled and re-examined to determine whether there were any differences as a function of position (pilot/copilot). These data are summarized in Table 3. In terms of increases in symptom frequency, a Sign test indicated no systematic impact of aircrew position.

Table 3. Number of aircrew that reported increases in symptom frequency as a function of position (pilot/copilot) from; Baseline to the end of Phase1, Baseline to the end of Phase 2, and the end of Phase 1 to the end of Phase 2.

Baseline To End Of Phase 1		Baseline To End Of Phase 2		End Of Phase 1 To End Of Phase 2	
Pilot in Phase 1	Copilot in Phase 1	Pilot in Phase 2	Copilot in Phase 2	Pilot to Copilot	Copilot to Pilot
5	4	5	5	4	5

An examination of responses to the Delayed Symptom Questionnaire revealed that following simulator exposure, symptoms associated with SIS either persisted or later developed in 7 of 16 aircrew (4 Novice and 3 Experienced). Again, the symptoms most frequently reported were 'physical fatigue' (n=5), 'mental fatigue' (n=4), 'eye strain' (n=3) and 'after sensations of motion' (n=2) (see Table 1). 'Physical fatigue' was present upon exit or developed within 2 h and lasted from 2 h (n=3) to 6 h (n=2). 'Mental fatigue' was present upon exit from the simulator or developed within 1 h and lasted up to 2 h. 'Eye strain' was present immediately following simulator sessions and lasted up to 2 h. 'After sensations of motion' were experienced immediately after simulator exposure and lasted 30 min in one case and 4 h in the other. Most other symptoms reported on the Delayed Symptom Questionnaire had immediate onset or became obvious within 1-2 h after leaving the simulator. The duration of these other symptoms ranged from 0.5 to 6 h, with a median of 2 h.

Overall, responses to the Symptom Questionnaires indicate that the majority of all aircrew experienced an increase in symptom frequency with simulator exposure and that the most frequently reported symptoms were mild 'mental fatigue', 'physical fatigue', 'eye strain' and 'after sensations of motion'. These same symptoms persisted after simulator exposure or in some cases developed shortly afterwards. However, for the most part, they dissipated within a few hours. The data did not indicate that the increases in symptom frequency associated with simulator exposure differed for Novice and Experienced aircrew nor that it was affected by whether aircrew assumed the position of pilot or copilot. However, caution should be exercised in interpreting these latter results due to the small sample sizes.

Summary Questionnaire

When aircrew were asked, on the Summary Questionnaire, whether they engaged in any particular activity after simulator training to relieve symptoms, 5 reported that they engaged in activities aimed at helping them relax and overcome fatigue. The remaining eleven reported that this question did not apply. Aircrew were also asked to describe any unusual sensations they experienced during flights on the same day following simulator training. Half reported that the question did not apply, presumably because some squadrons do not allow pilots to fly on the same day they receive simulator training, while the other half reported nothing unusual. In response to being asked if they ever experienced any unusual sensations while driving a motor vehicle following a simulator session, three pilots said the question did not apply while the remaining 13 reported no unusual effects.

Aircrew opinion regarding the fidelity of the simulator was assessed by examining responses to the Summary Questionnaire from the Experienced group, as these were the only individuals with current experience on the actual Aurora aircraft. On a 10-point scale, ranging from 'poor simulation' to 'identical to flight', the mean value obtained for the fidelity of physical and visual cues to motion was 5.8. On a 10-point scale pertaining to control/response lags, where 1 was 'excessive time lags' and 10 was 'no unusual time lags', the mean response was 4.4. These results indicate that the simulation had reasonable fidelity but that it did not mimic the aircraft so well as to preclude aircrew from experiencing conflicts between the simulator performance and their expectations from flying the Aurora.

Postural Stability

Postural stability data were based on lateral and sagittal deviations (sway). Total sway was calculated by summing the lateral and sagittal components. Table 4 summarizes mean total body sway for both the Novice and Experienced groups on the SR and R. Separate two-way repeated measures analyses of variance on these data failed to establish any significant differences between groups on either test. Furthermore, one sample t-tests failed to yield any significant differences within either group from Baseline to the end of Phase 1, or from the end of Phase 1 to the end of Phase 2. These results are consistent with the subjective data from the symptom questionnaire, which indicated that balance related items such as 'leans' (#9), 'walking a straight line takes more effort' (#13), 'difficulty maintaining balance' (#15), 'dizziness' (#18) and 'disorientation' (#28) were endorsed rarely.

Table 4. Mean total body sway values (J/Kg) (± SEMs) on the Sharpened Romberg and Romberg tests for Novice and Experienced Aircrew at Baseline, the end of Phase1, and the end of Phase2.

SHARPENED ROMBERG			
	Baseline	End Of Phase 1	End Of Phase 2
Novice	7.04 ± 1.11	8.94 ± 1.50	6.97 ± 1.40
Experienced	6.95 ± 1.35	8.02 ± 0.97	6.24 ± 0.99
ROMBERG			
Novice	2.44 ± 0.36	2.84 ± 0.52	1.92 ± 0.14
Experienced	1.76 ± 0.45	3.27 ± 1.53	1.51 ± 0.32

Workload

Mean NASA-TLX and global workload scores for both Novice and Experienced groups are presented in Table 5. Separate t-tests on these data failed to yield significant differences between groups on either workload measure, therefore, these data were pooled for further analyses. Unfortunately, workload could not be examined as a function of position because the nature of the protocol only allowed this measure to be taken after the entire 4 h session was completed.

Table 5. Mean NASA-TLX and global workload scores (± SEMs) for Novice (n=8) and Experienced (n=8) groups.

	NASA-TLX	GLOBAL WORKLOAD
Novice	9.87 ± 0.99	191.25 ± 39.57
Experienced	10.82 ± 1.06	359.38 ± 101.98

Mean NASA-TLX and global workload scores based on responses from all 16 aircrew were 10 and 275 respectively. Although the NASA-TLX score of 10 is not particularly high, the global workload score of 275 suggests that the simulator sessions were perceived as requiring substantially higher workload than take off and departure under VFR conditions.

In an attempt to determine the relative contribution to overall workload from the various dimensions assessed by the NASA-TLX, data from each of the 6 scales were examined separately. Mean weighted and unweighted values for the scales are presented in Table 6. An examination of the weighted data from Table 6 shows that the dimension contributing the most to overall workload was 'Mental Demand' followed by 'Temporal Demand' and 'Effort'. A similar pattern is seen in the unweighted scores. In addition, examination of the unweighted scores reveals that

'Mental Demand' and 'Effort' were the only scales endorsed on average beyond the mid-point of the 18-point scale (13 and 12 respectively).

Table 6. Mean weighted and unweighted values (± SEMs) from each of the 6 scales of the NASA-TLX based on 16 aircrew.

	Frustration	Temporal Demand	Mental Demand	Physical Demand	Performance	Effort
Weighted	17.00 ± 6.63	32.06 ± 5.48	48.50 ± 5.48	9.81 ± 2.62	16.69 ± 2.46	30.50 ± 4.30
Unweighted	7.00 ± 1.37	8.69 ± 0.93	13.00 ± 0.71	7.75 ± 0.84	5.88 ± 0.84	12.06 ± 0.87

In an attempt to determine whether there was a relationship between workload and symptomatology, i.e., did those individuals who experienced high workload also show greater increases in symptomatology, aircrew were separated (median split) into two groups based on reported increases in symptom frequency. The two groups are consequently referred to as High and Low symptom groups. Overall NASA-TLX and global workload scores were compared for the High and Low symptom groups. These data are presented in Table 7. Separate t-tests on these data failed to yield any significant differences between groups. A similar set of analyses, where aircrew were split into two groups on the basis of symptom frequency for 'mental fatigue', 'physical fatigue', 'eye strain' and 'after sensations of motion' also failed to establish any workload differences between High and Low symptom groups.

Table 7. Mean NASA-TLX and global workload scores (± SEMs) for High and Low Symptom groups.

	NASA-TLX	GLOBAL WORKLOAD
Low	10.03 ± 1.02	216.25 ± 43.17
High	10.45 ± 1.10	239.29 ± 52.69

Overall, these results suggest that the workload was relatively high during simulator sessions for all aircrew but was no different for Novice and Experienced aircrew.

In addition, the dimension of the NASA-TLX that loaded the highest was 'mental demand', followed by 'effort' and 'temporal demand', which contributed about equally. Insufficient differences in workload were obtained between the HS and LS groups to reveal statistical significance.

DISCUSSION

The results of this study indicate that over 50% of the aircrew experienced an increase in symptom frequency following training on the FDS with the most commonly reported symptoms being mild 'mental fatigue', 'physical fatigue', 'eye strain' and 'after sensations of motion'. Based on this sample of pilots, increases in symptom frequency were no different for Novice and Experienced aircrew nor for pilots and copilots. The results failed to yield any indication that aircrew experienced postural instability following the simulator training sessions, however, there was evidence to suggest that workload in the cockpit was elevated.

The finding that mild 'mental fatigue', 'physical fatigue', 'eye strain' and 'after sensations of motion' were frequently reported symptoms and that these were reduced considerably within a few hours following simulator exposure is consistent with the results of a previous study which examined SIS symptomatology in the CC-130H Hercules transport simulator at CFB Trenton (13). The finding that there were no differences between Novice and Experienced aircrew, in terms of symptom frequency, is also in agreement with these results (13), however, this pattern of effects is inconsistent with several studies which have argued that experienced aircrew are more susceptible to SIS than novices (2,5,9-12). One possible reason for this discrepancy is that while the Aurora and Hercules simulators clearly generate symptoms associated with

SIS, symptoms of fatigue and eye strain are probably not related to the primary etiology of SIS, namely exposure to sensory conflicts generated by the abnormal environment in the simulator cockpit. This possibility is supported by studies such as those of Kennedy et al. (2), which have identified the primary symptoms of SIS as nausea, dizziness and postural instability. None of these symptoms were observed in the present study. Although there were some reports of 'after sensations of motion', this is typical of prolonged exposure to any type of moving vehicular environment and is unlikely a flight safety concern since this symptom was unaccompanied, to any extent, by such symptoms as 'leans' (item #9), 'walking a straight line requires more effort' (item #12), 'difficulty maintaining balance' (item # 15), 'dizziness' (item #18), 'vertigo' (item # 22) or 'disorientation' (item # 28). The results of this study suggest that factors other than sensory conflicts were responsible for the pattern of symptoms observed.

The possibility that gross measures of SIS symptomatology reflect a number of contributing factors has been suggested previously (5,6) and the results of this study suggest that elevated workload may have contributed to the pattern of symptoms observed. The possibility that workload may be in part responsible for the pattern of symptoms endorsed following simulator exposure is consistent with three sets of findings: (a) global workload scores appear to be relatively high, (b) the dimensions of the NASA-TLX receiving the highest endorsements were 'mental demand', 'effort' and 'temporal demand', and (c) responses to the summary questionnaire indicated that a number of aircrew engaged in activities to relax and overcome fatigue following simulator sessions.

Given the high task demands inherent in simulator training, and the prolonged exposure to CRT displays, it is not surprising that fatigue and eye strain developed. While the failure to demonstrate workload differences for experienced and novice aircrew may seem unexpected, one possible explanation for this finding is that routine flight procedures are equally as demanding for novices as training on difficult emergency procedures are for experienced aircrew.

Finally, since the increases in symptom frequency were no greater for pilots than for copilots, it appears that there were no unusual control/response characteristics present in the simulator. This is supported by responses to the Summary Questionnaire, which indicated that the simulator had reasonably good fidelity and that control/response lags were not considered to be overly excessive. With regard to the lack of SIS development, however, it is noteworthy that the fidelity ratings were not so high that the preconditions necessary for the development of SIS were absent.

In conclusion, the results of this study suggest that workload induced-fatigue was likely responsible for the pattern of symptoms observed following simulator sessions. This observation is of interest from both a theoretical and practical point of view. Theoretically, it supports the argument that the subjective changes following simulator exposure may be due to several factors including sensory conflict and workload induced-fatigue. Practically, the results suggest that it would be useful to identify the specific factors responsible for particular sets of symptoms observed following simulator training in order that SIS can be defined and managed more effectively. Finally, it would also be useful to examine symptomatology and workload in the actual Aurora aircraft to determine the extent that responses to the simulator and the real aircraft differ.

While it is always prudent to maintain flight restrictions to maximize flight safety, the present study found no evidence to support the contention that the Aurora simulator produces the classical symptoms of simulator sickness. On the other hand, the high task demands associated with simulator training seem to lead to a mild, though not debilitating, increase in fatigue. Though any increase in fatigue levels of aircrew has the potential to compromise performance and safety, the actual impact of the simulator mission on subsequent activities will be dependent on the increase in fatigue for specific individuals coupled with the demands associated with those subsequent activities.

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Abstract

Training on modern flight simulators can lead to a condition referred to as simulator induced sickness (SIS) which is characterized by nausea, dizziness and postural instability. It is believed that SIS results from exposure to conflicting sensory information. The present report examined the incidence, severity and duration of SIS as a function of flight experience and aircrew position (pilot/copilot) in 16 aircrew following training on the CP-140 (Aurora) Flight Deck Simulator at Canadian Forces Base Greenwood. The dependent measures included symptomatology and postural stability. In addition, measures of workload were taken to examine the contribution of the high task demands generally associated with simulator training to the development of SIS symptomatology. The results indicated that over 50% of tested aircrew experienced increases in symptom frequency following simulator training with the most commonly reported symptoms being mild mental fatigue, physical fatigue, eye strain and after sensations of motion. This increase in symptom frequency was unaffected by either flight experience or aircrew position and symptoms dissipated, for the most part, after a few hours. No changes in postural stability were observed. The workload results confirmed that the simulator imposed high task demands on the aircrew. Furthermore, the workload results were consistent with the pattern of symptoms observed, suggesting that factors other than sensory conflict may be involved in the development of symptomatology following simulator exposure. Future investigations should attempt to identify these factors so that SIS can be managed more effectively.

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KEYWORDS: Simulator Sickness; Ataxia; Postural Control; Workload.